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THE GPALS SYSTEM AND ITS ELECTROMAGNETIC THREAT ENVIRONMENT

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ABSTRACT Recounts in simple terms the basic components of the U.S. defense against limited attack global protection system (GPALS), combat methods, as well as primary tactical techniques and performance characteristics. There is a relatively complete introduction with regard to electromagnetic threat environments met with during strategic defense penetration processes.

KEY TERMS GPALS system Missile Antimissile missile Defense penetration

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On 29 January 1991, U.S. President Bush, when giving the State of the Union Message, clearly announced, "I have already directed that the focus of the SDI project be changed to defense against limited ballistic missile attacks, no matter from where these missiles come." In this way, he then made the original deployment of "SDI-I", which had been aimed primarily against a large scale missile offensive by the former Soviet Union and with a research focus on so called "first stage strategic defense systems", turn toward the GPALS plan, which is directed primarily against unintentional Soviet launches or unauthorized launches as well as small scale missile attacks launched by third world countries and with a research focus on the "global protection against limited attack system", thereby reconciling the two divergent viewpoints of the supportive faction in Congress and the anti SDI faction. The rate of support in Congress for the SDI project clearly strengthened. The budget was not only increased (the first time SDI expenditures had grown in several years), moreover, there was a requirement that the U.S. government--beginning in 1996--deploy on the U.S. mainland a ground based antimissile defense system that does not violate the antiballistic missile treaty which is currently in effect. 1991 is the single year in which the largest number of important tests was carried out since the SDI project was put forward. On the basis of open source reports, in 1991, in the three key technological realms of detection techniques, kinetic energy weapons, and directed energy weapons technology, a total of over 20 projects and more than 30 large scale tests were carried out. Among these, most of the tests achieved success, resolving a number of difficulties in the development process. In the areas of detection technology as well as kinetic energy interceptor missile technology, the progress achieved was outstanding. Now, we will make an explanation of the basic components of GPALS systems as well as their tactics and technological performance characteristics.

1 SYSTEM CHARACTERISTICS AND PERFORMANCE

GPALS systems are made up of three components.

(1) Space Based Boost Phase and Terminal Boost Phase Defense Systems. As far as space based boost phase and terminal boost phase defense systems are concerned, they are composed of 1000 "intelligent (bright) pebble" interceptor missiles BP. The interceptor missiles in question are a type of highly autonomous space based defensive weapon. They are capable of using multiple types of detection devices which they carry within themselves, detecting the launch of the other side's missiles, tracking the heat plumes of booster rockets to calculate the trajectory of enemy missiles. After that, control is automatic and targets are destroyed. BP interceptor missiles are primarily used in the interception of long range missiles in flight during boost phase and terminal boost phase. In boost phase, there is also a

possibility of intercepting theater ballistic missiles with ranges greater than 600km. This type of capability primarily depends on the boost phase flight time of this type of missile and maximum missile altitude characteristics.

(2) Ground Based U.S. Mainland Strategic Defense Systems. The systems in question are composed of command centers, space based and ground based detectors connected together, as well as ground based kinetic energy interceptor missiles, and so on. Detection devices primarily include space based "bright eyes" (BE) and terminal ground based radars "GBR-T". Ground based surveillance and tracking systems GSTS are optional plans. As far as ground based kinetic energy interceptor missiles are concerned, there are two types of designs. One type is used in intermediate defense ground based interceptor missiles GBI. The other type is used in terminal defense interceptor missiles E2I inside and outside the atmosphere. With respect to which type is selected for use in the end or whether the two are utilized in combination, it will be determined by the level of funding /8 support. No matter which of these interceptor missiles are selected for use, they all require BE, GBR-T, as well as GSTS to supply target control information. In accordance with the requirements of projects at the present time, the U.S. plans to make purchases of 750 ground based kinetic energy interceptor missiles, 60 "bright eye" satellites, and 6 ground based radars.

(3) Tactical and Theater Missile Defense Systems which Can Be Deployed Mobilly. Tactical and theater missile defense systems are composed of command centers, interceptor missiles, and ground based radars. "Bright eye" satellites can supply early warning for the systems in question. Tactical and theater missile defense systems which are just in the midst of research and testing are comprised of the improved Patriot PAC-3 missile system, the strengthened intercept missile system ERINT, as well as the theater high altitude area defense system THAAD.

As far as constituents for the whole system are concerned, see Fig.1 GPALS Components.

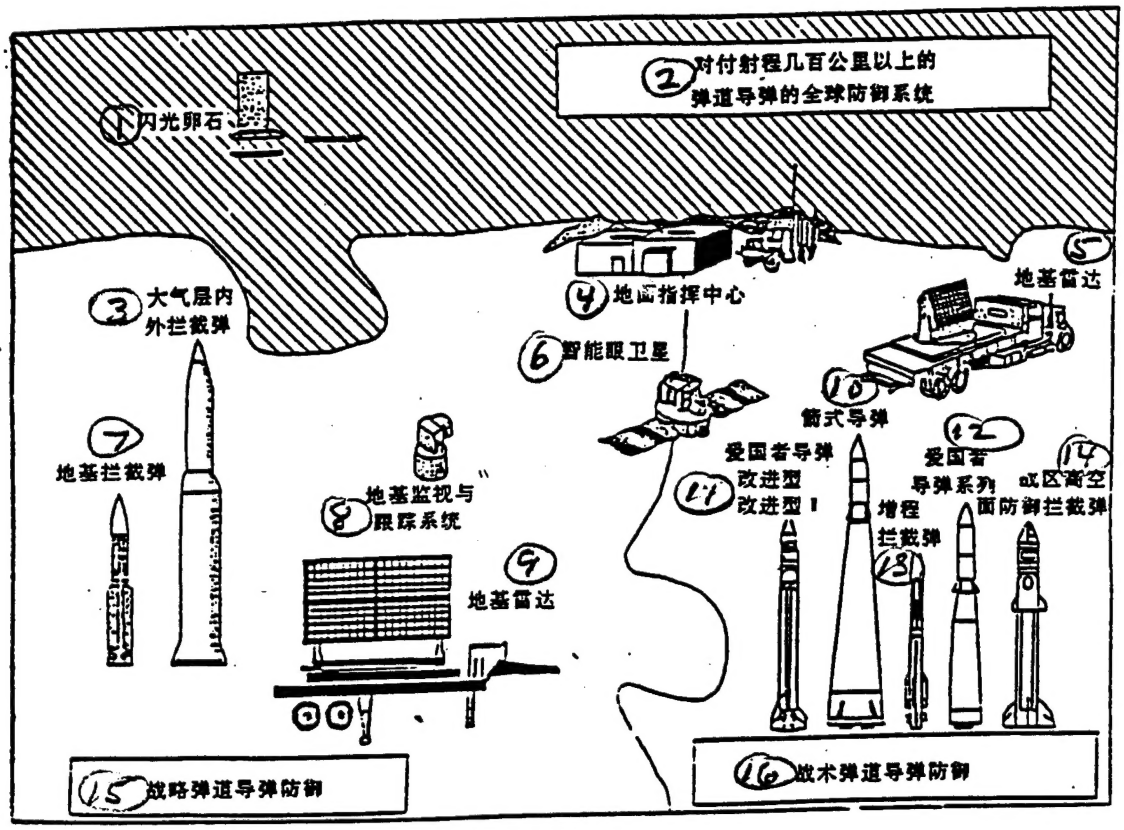

Fig.1 GPALS Components

Key: (1) Flash Pebbles (2) Ballistic Missile Global Defense Systems Dealing with Ranges of a Few Hundred Kilometers or More (3) Interceptor Missiles Inside and Outside the Atmosphere (4) Ground Command Center (5) Ground Based Radar (6) Bright Eye Satellite (7) Ground Based Interceptor Missiles (8) Ground Based Surveillance and Tracking System (9) Ground Based Radar (10) Arrow Type Missile (11) Patriot Missile Improved Version Improved Version II (12) Patriot Missile Series (13) Extended Range Interceptor Missile (14) Theater High Altitude Defense Interceptor Missile (15) Strategic Ballistic Missile Defense (16) Tactical Ballistic Missile Defense

2 SYSTEM DETECTION TECHNOLOGY AND INTERCEPTOR MISSILE TECHNOLOGY

(1) Space Based Detection Devices (BE). Space based detection devices are primarily "bright eye" satellites (BE). They will be used in order to replace space surveillance and tracking systems (SSTS).

BE is a composite product of BP, SSTS, and GSTS. It is used in order to guide ground based defense missiles, making them aim on incoming warheads. Besides this, BE is also capable of identifying true and false warheads, estimating defensive results, and predicting warhead attack points. As a result--within GPALS--option is made in all cases for the use of BE in order to increase attack effectiveness. BE is composed of constellations of light satellites at dispersed altitudes. Compared to SSTS, BE track altitudes are even lower than (illegible) close to the detected targets. As a result, it is even easier to identify detected targets (illegible) detection devices are capable of tracking targets possessing (illegible) against the background of cold space. The autonomous capabilities are relatively strong. They are able to supply to ground based defenses information relating to incoming warheads and decoy dimensions as well as structure.

As far as estimated BE detection device dimensions are concerned, they are only one tenth those of SSTS. The gross weight of each BE satellite is not greater than 450kg. As a result, a delivery means on the order of one "Spirit of the Cosmos" is then capable of launching multiple BE. Originally, the first stage system calculated the deployment of 18 SSTS. However, due to BE track altitudes reaching 900km--which is double BP--as a result, GPALS deploys approximately 50 BE.

The identification of true and false warheads and precise aiming associated with detection devices are one of the primary difficulties which the project in question encounters.

(2) Ground Based Radars. In GPALS system plans, there are two types of ground based radars planned for adoption and use. One type is designated the terminal ground based radar "GBR-T", which supplies ground based strategic defense uses. The other type is designated the theater missile defense ground based radar "TMD-GBR", which supplies theater missile defense uses. Both /9 these two types of radars are improved models of ground based radars GBR originally studied by SDI. The basic plan is a type of single array, mobile X wave band phase control array radar primarily used in surveillance, acquisition, tracking, and identification of warheads in intermediate stage flight. As far as ground based radars after improvements are concerned, the main characteristics are:

i) GBR-T radar antenna dimensions are 6.1mx3.6m (the original plan was 27m long);

ii) radars are capable of deployment by highway movement (the original plan was deployment by railroad movement);

iii) option is made for the use of modular type design plans with theater missile defense ground based radars only having one common use phase controlled array antenna module (PAAM), however, GBR-T have 4 PAAM modules. Hereafter, it is also possible to develop high power radars with even more modules.

There are two types of ground based radar plans just now being studied. One type makes use of currently existing traveling wave tube technology. The other type opts for the use of advanced solid state technology. Minimum detection ranges associated with TMD-GBR radars are targets 250km distant. However, the Army Strategic Defense Headquarters requires the capability to detect 500km distant targets. Radars adopt 90° fan hemisphere searches. The prime radar contractor is the Raytheon Company. In the middle of 1995, two units were developed capable of supplying TMD-GBR radar prototypes for actual combat deployment as well as a prototype to use in experimentally verifying GBR-T radar. Full engineering development begins in 1996.

The combat mode of the GPALS system before the year 2000 is seen in Fig.2.

Seen from the angle of strategic missile defense penetration, missiles at this time will--in boost phase and terminal boost phase and in warhead intermediate and terminal phases--be subject, during the entire missile flight process, to interception by kinetic energy weapons, microwave directed radiation weapons, and radio frequency (directed radiation

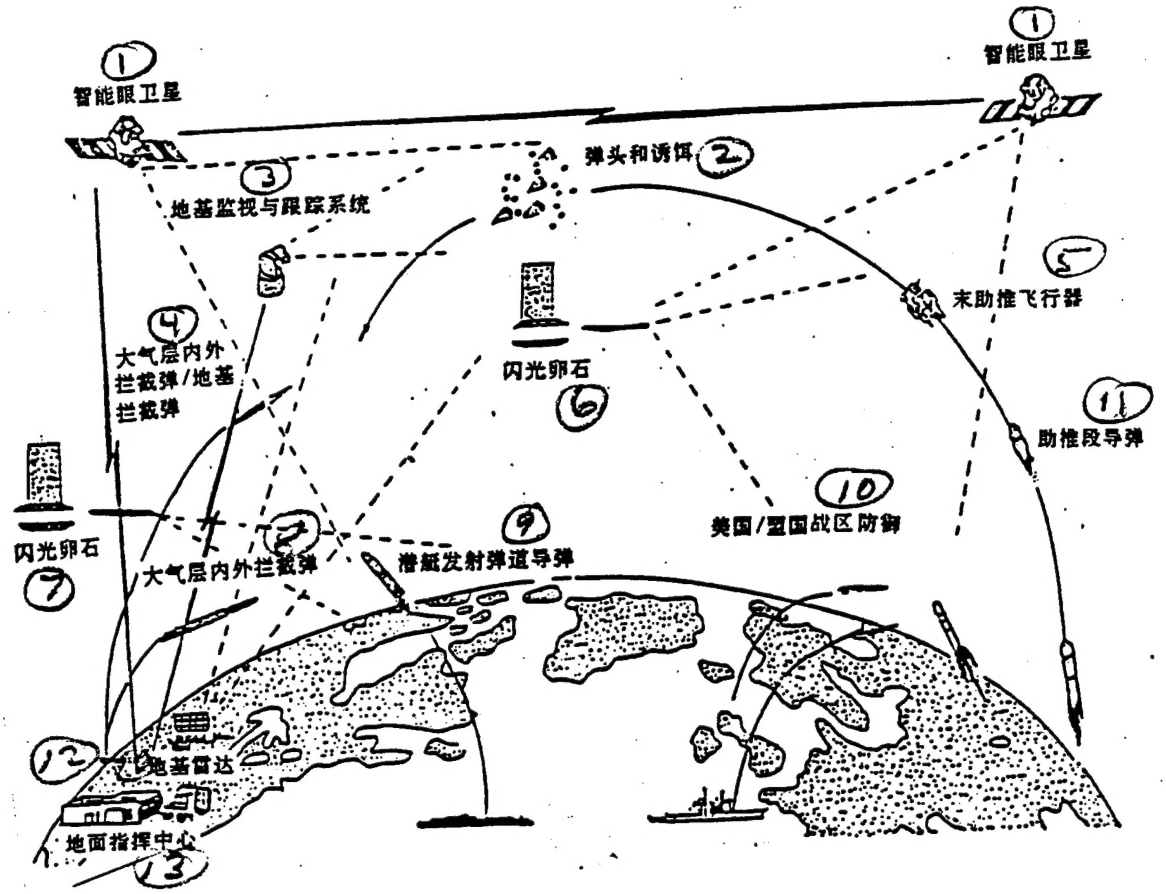

Fig.2 GPALS Combat Mode

Key: (1) Bright Eye Satellite (2) Warheads and Decoys (3) Ground Based Surveillance and Tracking System (4) Interceptor Missiles Inside and Outside the Atmosphere/Ground Based Interceptor Missiles (5) Terminal Boost Flight Craft (6) Flash Pebbles (7) Flash Pebbles (8) Interceptor Missiles Inside and Outside the Atmosphere (9) Submarine Launched Ballistic Missiles (10) U.S/Allied Theater Defense (11) Boost Phase Missile (12) Ground Based Radar (13) Ground Control Center

electromagnetic pulse) weapons. Seen from the angle of counter detection and counter identification, primary susceptibility is to infrared and visible light detection. For the sake of clarity, various types of detection threats and attack threats encountered by strategic missiles and their warheads during defense penetration countermeasures are summarized in Table 1. From the table, it is possible to see that attack threats experienced in this century are high speed kinetic energy kills and damage. At the beginning of the next century it is also possible to add microwave directed radiation weapons and radio frequency weapons. Detection threats experienced are primarily infrared and visible light photoelectric environmental threats. Electromagnetic environment threats associated with radar detection and identification are reduced in relative terms. /10

3 DISCUSSION OF STRATEGIC DEFENSE PENETRATION ELECTROMAGNETIC THREAT ENVIRONMENTS

From the components, performance, and characteristics of GPALS systems, it is possible to see that the systems in question have expended very large outlays in order to resolve such operational links as acquisition, identification, positioning, and so on, associated with information on attacking warheads. In GPALS systems, the detection and identification means applied almost cover the entire frequency band from microwaves, millimeter waves, infrared, and visible light up to ultraviolet. The entire system increases sensitivity and antijamming capabilities. In this way, very great difficulties are then increased in the application of defense penetration techniques. For this reason, the application of various types of photoelectric techniques--such as decoys as well as active jamming, and so on--all require close integration with the characteristics of this GPALS electromagnetic, photoelectric composite threat environment in order to be carried out. It is necessary to understand the basic characteristics associated with detection devices applied to GPALS detection and identification systems, means and methods associated with frequency bands and target acquisition characteristics, identification principles, information processing methods, as well as counter jamming means. In particular, in GPALS systems, broad application is made of millimeter wave and infrared technologies which have still not been used in past antimissile missile systems. This is one type of new electromagnetic threat means. In view of this, unceasing intensification in dynamic tracking as well as analysis and research associated with the systems in question is completely necessary.

Second, it is necessary to strengthen research associated with system analysis as well as defense penetration countermeasures. Strategic missiles, beginning from their launch, will be subject to surveillance and tracking from U.S. DSP early warning satellites positioned at 36000km altitudes in

equatorial high altitude geosynchronous orbits. "Bright eye" satellites BE in low orbits are capable of carrying out intercepts against target booster phases as well as terminal booster phases. Targets during intermediate flight will be subject to intercepts by ground based interceptor missiles GBI. Before, during, and after the reentry phase, they will also be subject to image recognition and track measurement. At different altitudes, they are subject to layered interception by theater high altitude air defense interceptor missiles (THAAD), Patriot missiles (PAC series), as well as extended range interceptor missiles (ERINT). In order to penetrate this set of integrated defensive systems, it is necessary to carry out research associated with countermeasure technologies in the layers of the system. From the system angle, analysis is done of the applications associated with various types of electromagnetic and photoelectric threat environments as well as their effects, searching out countermeasures which can actually be carried out as well a estimates associated with result applications.

Once again, due to changes associated with the international set up and the strategic circumstances as well as important steps forward in technology, defense penetration countermeasure problems associated with missile warheads have already deepened from the original narrow sense of the concepts. First of all, there has been a change into integrated defense countermeasures associated with missiles and defensive systems. Going even a step further, there has already been a change into defense penetration countermeasures associated with integrated offensive systems and defensive systems. As a result, seen in terms of the

Table 1 Forms of Environmental Threat and Attack Threat which Missiles and Missile Warheads Are Subjected to During Defense Penetration Countermeasures

(1) 威胁部署情况		(2) 探测威胁							攻击威胁 (3)
		红外 (4)			(16) 紫外	(11) 可见光	(12) 激光	(13) 雷达波	
(5) 时间	类型 (6)	(7) 长波	(8) 中波	(9) 短波					
(14) 已有的	预警卫星(DSP) (17)	✓	✓	✓		✓			
	预警雷达 (18)							✓	
(15) 本世纪末	地基拦截弹(GBI) (19)	✓	✓			✓			动能杀伤 (25)
	地基监视与跟踪系统(GSTS) (20)	✓							
	地基雷达(GBR) (21)							✓	
(16) 下世纪初	智能眼探测卫星(BE) (22)	✓	✓	✓	✓	✓	✓		
	智能卵石拦截弹(BP) (23)	✓		✓					动能杀伤 (25)
	定向能武器 (24)								微波武器 (26)
									射频武器 (27)

Key: (1) Threat Deployment Status (2) Detection Threat (3) Attack Threat (4) Infrared (5) Time (6) Type (7) Long Wave (8) Medium Wave (9) Short Wave (10) Ultraviolet (11) Visible Light (12) Laser (13) Radar Waves (14) Already Exist (15) End of This Century (16) Beginning of the Next Century (17) Early Warning Satellites (DSP) (18) Early Warning Radar (19) Ground Based Interceptor Missiles (GBI) (20) Ground Based Surveillance and Tracking Systems (GSTS) (21) Ground Based Radars (GBR) (22) Bright Eye Detection Satellites (BE) (23) Bright Pebble Interceptor Missiles (BP) (24) Directed Energy Weapons (25) Kinetic Energy Kills and Damage (26) Microwave Weapons (27) Radio Frequency Weapons

analysis of defense penetration strategies and means as well as technological avenues, adopting any single type of path, it is very difficult in all cases for countermeasures to missile defense systems of the next century. If integrated, in depth conceptual research is not carried out from the angle of large systems, and only a number of defense penetration measures are adopted on missiles in a piece meal manner, it is possible that the overall results will be very bad--even to the point of being irremediable. In view of the fact that, from now on, detection and recognition environments encountered by missile warheads experience relatively great changes--that is, a shift of focus from electromagnetic environments associated with radar toward photoelectric environments--there should, therefore, be particular emphasis laid on carrying out mutually complementary research on these two environments.

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